EMPIRE
SOILS INVESTIGATIONS INC.

HYDROGEOLOGIC INVESTIGATION
CROUSE-HINDS LANDFILL
SYRACUSE, NEW YORK

FOR

Crouse-Hinds Company, Inc.

Syracuse, New York

Job No. GTA-82-44

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355382

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1.0 INTRODUCTION

Thomsen Associates was retained by Crouse-Hinds Company to perform a hydrogeologic investigation at their landfill north of Seventh North Street. This report presents our findings, conclusions, and recommendations from our analysis of data obtained during our investigation at the site. This report is presented to Crouse-Hinds in accordance with P. O. F337014A issued September 20, 1983 by Crouse-Hinds Company and completes our contract to Crouse-Hinds Company for P. O. F337014A.

Assistance during the project was provided by David Ronkainen from Crouse-Hinds, Gregory DeSantis from Calocerinos and Spina, and Stephen Rossello from Thomsen Associates.

1.1 Purpose and Scope

The purpose of our investigation was to determine the direction of groundwater flow beneath the landfill in the peat deposits underlying the foundry waste and in a sand and gravel layer separated from the peat by 12 to 52 feet of silt and clay. Specifically the work was to include:

- Locating and designing six monitoring well clusters which would include two for sampling and four for determining groundwater movement.

- o Installing the monitoring well clusters under the supervision of a geologist from our staff.
- o Interpreting groundwater measurements taken by others and preparing a report after one year of seasonal sampling.

The scope of this report is limited to:

- o Review of available geologic information on the area.
- o Analysis of data obtained from soil borings and monitoring wells installed by Empire Soils Investigations, Inc. under the supervision of a geologist from Thomsen Associates for this study.
- o Analysis of data obtained from boring logs drilled by Parratt-Wolff for a previous study.
- o Analysis of water level data provided by Calocerinos and Spina.

This report has been prepared for the exclusive use of Crouse-Hinds Company for specific application to their landfill north of Seventh North Street in accordance with generally accepted hydrogeologic practices.

1.2 Methodology

1.2.1 Borings

Eleven borings were drilled during the investigation (E-1, E-2, E-3, W-4A, W-4B, W-5, W-6A, W-6B, W-7, W-8A and W-8B). A rotary drill rig was used to advance the borings. Five of the borings were 42-62 feet deep and used a combination of 3-3/4 inch ID hollow stem auger casing and 4 inch ID NW casing to advance the hole (W-4B, W-5, W-6B, W-7 and W-8B). Next to three of the deep borings, shallow borings 12-20 feet deep were drilled using a 3-3/4 inch ID hollow stem auger casing (W-4A, W-6A and W-8A). Three borings 27 feet deep were drilled west of the landfill using a 3-1/4 inch ID hollow stem auger casing (E-1, E-2 and E-3). The location of all borings is shown on Figure 2 and boring logs are found in Appendix A.

1.2.2 Soil Sampling

Soil samples were taken in the eight deeper borings (E-1, E-2, E-3, W-4B, W-5, W-6B, W-7 and W-8B). Soil samples were not taken in the three shallow borings drilled next to deeper borings (W-4A, W-6A and W-8A). Samples were taken using a two-foot split-spoon sampler. Split spoon samples were taken in general accordance with ASTM Method D-1586. However, the split spoon sampler was driven 24 inches for each sample rather than the 18 inches specified in ASTM Method D-1586. The depth where samples were taken in each boring is shown on the boring logs. All samples were visually classified in the field by a geologist.

1.2.3 Monitoring Wells

Monitoring wells were installed in eight of the eleven borings (W-4A, W-4B, W-5, W-6A, W-6B, W-7, W-8A and W-8B). The observation wells were constructed of threaded flush-joint, two-inch diameter PVC pipe with machine slotted well screens having 0.02 inch slots. All joints were sealed with teflon tape. The observation wells were installed inside the hollow stem auger to allow for placement of clean sand around the well screen and a bentonite seal above the sand. All wells except for W-4B have a five-foot well screen. Well 4B has a ten-foot well screen. A sand pack was placed around the well screen. Above the well screen the annular space was sealed with bentonite and grout seal to prevent leakage down the well casing. A locking metal protector pipe was cemented over the PVC pipe.

The shallow wells (B-4A, B-6A and B-8A) were placed in a peat layer beneath the fill. The deeper wells (W-4B, W-5, W-6B, W-7 and W-8B) were installed in a deeper sand and gravel layer separated from the peat by 12-54 feet of silt and clay.

1.2.4 Field Hydraulic Conductivity Tests

A field test was performed on Well-6A to obtain an estimate of the hydraulic conductivity of the peat underlying the foundry waste. The methodology of Bouwer and Rice (1976) was used to perform the field tests and analyze the data. Results from the field test are found in Appendix E.

1.2.5 Water Elevations

All wells were developed by bailing following their installation. Water levels were taken monthly between December, 1982 and October, 1983 by Calocerinos and Spina. Thomsen Associates surveyed the locations and elevations of all wells. Vertical elevations were referenced to a bench mark in the center of the landfill which is the top of the spindle on a fire hydrant.

2.0 GEOLOGY

2.1 General Geology

The Crouse-Hinds landfill is located northeast of Seventh North Street and south of Ley Creek in Syracuse, New York (Figure 1). It is approximately 1 mile east of Onondaga Lake. The landfill is located within the Ley Creek stream valley. Subsurface deposits consist of over 80 feet of alternating layers of sand, silt and clay overlying shale and dolostone bedrock of Silurian Age. (Richard and Fisher, 1970). The majority of the unconsolidated deposits are of glacio-lacustrine origin, deposited at the end of the last glaciation. However, more recent organic deposits are found above glacio-lacustrine deposits in the area.

2.2 Site Geology

The soils encountered beneath the landfill can be divided into 3 units, organic deposits, silt and clay, and a sand and gravel layer. The eleven borings drilled by Empire Soils Investigations were used in conjunction with borings from previous investigations to develop geologic profiles of the subsurface deposits showing the relationship between the organic deposits, silt and clay, and sand and gravel layers. The location of the geologic cross sections and borings is shown on Figure 2. The geologic profiles are shown on Figures 7 and 8.

As shown on the geologic profiles (Figures 7 and 8), the foundry waste has been placed on top of organic deposits. The organic deposits are identified as peat on the geologic profiles and consist of organic silt, peat, marl and fine sand. The thickness of organic deposits encountered in the borings through the landfill ranged from 0.5 inches at W-5 to 9 feet at W-8B. The borings west of the landfill (E-1, E-2, and E-3) encountered 10.5 to 17 feet of organic deposits. In some areas the peat has been compressed by the fill and pushed out the edges of the landfill so only traces of peat were encountered (W-5).

Glacio-lacustrine deposits consisting of predominantly silt and clay are found below the organic deposits. The top of the glaciolacustrine silt and clay unit is found between elevations 354 and 360. The glacio-lacustrine silt and clay deposits varied from 12 feet thick at B-2 to 54 feet thick at B-4. The silt and clay deposits are thickest in the southwestern portion of the landfill (B-4, W-6B, W-7). In the area where the thickest silt and clay deposits occur a layer of silt and fine sand was found in the upper part of the silt and clay deposit (see cross sections A-A' and B-B', Figures 7 and 8). The silt and clay deposit thins to the east. Only 14 feet of silt and clay were found at W-4B.

Sand and gravel are found below the silt and clay glaciolacustrine deposits. This deposit consists of medium to coarse sand with some gravel. Borings drilled for this investigation did not encounter the bottom of the sand and gravel deposit. However, previous borings indicate this deposit is at least 20 feet thick (Appendix C).

3.0 GROUNDWATER FLOW

Monitoring wells were installed around the periphery of the landfill to determine the direction of groundwater flow in the organic deposits directly beneath the landfill and in the deeper sand and gravel layer which is separated from the organic deposits by 12 to 54 feet of silt and clay. Water levels in three new observation wells (W-4A, W-6A and W-8A) and three wells previously installed by others (W-1, W-2 and W-3) were used to determine the direction of groundwater flow in the organic deposits. Five new wells (W-4B, W-5, W-6B, W-7 and W-8B) were installed in the sand and gravel layer to determine the direction of groundwater flow in this unit. Water level elevations were taken monthly between December, 1982 and October, 1983, to investigate seasonal variations in the direction of groundwater flow. Groundwater in the organic deposits is under water table conditions. The direction of groundwater flow in the organic deposits is shown on the water table map, Figure 3. Water table contours for both summer and winter conditions were plotted. The general direction of groundwater flow (west) beneath the landfill in both summer and winter is eastward, toward Ley Creek. However, during the winter a groundwater divide is found in the middle of the landfill so there is a component of flow toward the south. The hydraulic gradient of the water table varies from 0.025 ft/ft to 0.0025 ft/ft. ?

The average linear velocity of groundwater flow through the peat deposit beneath the landfill can be calculated using Darcy's Law, $\bar{v} = Ki/n$ where $\bar{v}$ is the average linear velocity of flow, K is the hydraulic conductivity, i is the hydraulic gradient, and n is effective porosity. A "slug" test was performed on W-6A to evaluate the hydraulic conductivity of the organic deposits following the methodology of Bouwer and Rice (1976) (Appendix E). The result of the field test indicates a hydraulic conductivity of $5x10^{-4}$cm/sec. However, Todd (1980) estimates the hydraulic conductivity of peat is an order of magnitude higher, about $7x10^{-3}$cm/sec. Therefore, in calculating the velocity of groundwater flow in the organic deposits $5x10^{-3}$cm/sec was used for hydraulic conductivity to provide an upper limit on the rate of groundwater flow in the peat deposit. Assuming $K = 5x10^{-3}$cm/sec, i = 0.01 ft/ft (average gradient during August) and n = 0.44 (Todd, 1980) the average linear velocity of flow in the peat deposit beneath the landfill is about 120 ft/year. Since the landfill is within 350 feet of Ley Creek, groundwater flowing beneath the landfill in the organic deposits should reach Ley Creek within three years.

Well W-4A is generally upgradient of the landfill. However, water level readings in December-March show there was a slight gradient from W-2 toward W-4A. Thus, W-4A is not always upgradient of the landfill so can not be considered outside the influence of the landfill.

Five new piezometers were installed in the deep sand and gravel aquifer to investigate groundwater flow conditions in this unit. The sand and gravel layer is separated from the organic deposits by at least 12 feet of silt and clay. The annular space around the pipe in the bore hole was sealed with a bentonite and cement grout above the well screen to ensure that water level measurements in these wells reflect the potentiometric surface of the sand and gravel aquifer. The water level measurements in the deep wells indicate there is a significant seasonal change in the potentiometric surface of the sand and gravel aquifer (Figures 4-6). During the summer the general direction of groundwater flow beneath the landfill in the sand and gravel aquifer is toward the east (Figure 6). Water level measurements also indicate the sand and gravel aquifer is under artesian conditions (Figure 8). Except at W-4A and W-4B, the vertical gradient between the sand and gravel aquifer and organic deposits beneath the landfill is upward during the summer months.

However, in the winter the direction of groundwater flow in the sand and gravel deposit changes 180°. Water level measurements in the deep wells between late December and March indicate the general direction of groundwater flow in the sand and gravel aquifer is westward (Figures 4 and 5). The potentiometric surface also is much lower in the winter, declining 15 to 20 feet in all wells except W-4B. With the decline in the potentiometric surface, the vertical gradient also changes. Although the sand and gravel aquifer is still under artesian conditions, the vertical gradient in the winter between the organic deposits and sand and gravel layer is downward (Figure 7).

Any testing?

The thickness of the silt and clay deposit appears related to its effectiveness as a confining layer. At W-4B where the silt and clay deposit is only 14 feet thick water levels do not show the large seasonal variations found in the other deep wells where the silt and clay layer was at least 25 feet thick (W-8B, W-6B, W-7, W-8), and upward vertical gradients observed in the summer at other locations between wells in the sand and gravel aquifer and wells in the organic deposits were not found between W-4B and W-4A. This indicates that although the lower hydraulic conductivity of the silt and clay layer with respect to the overlying organic deposits will restrict the downward flow of leachate from the organic deposits to the sand and gravel aquifer, the silt and clay layers is not as effective a confining unit at W-4B as in areas where the vertical gradient is upward during half the year. The upward gradient provides an additional barrier to downward migration of leachate. Thus, the silt and clay layer is a more effective confining layer in areas where it is thicker because a hydrologic restriction (gradient) is added to the geologic restriction (low hydraulic conductivity) to the downward migration of leachate through the silt and clay layer.

Because of the seasonal reversal in flow direction between winter and summer in the sand and gravel aquifer, no wells are entirely upgradient of the landfill. However, W-8B is cross-gradient under both winter and summer flow conditions, and at the edge of the landfill, so it should provide background water quality. During summer flow conditions W-4B is downgradient of the landfill while during winter flow conditions W-5, W-6B and W-7 are downgradient of the landfill.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Monitoring wells installed in the organic deposits beneath the fill confirm earlier investigations which indicated groundwater flow beneath the landfill in this deposit was westward, toward Ley Creek. Groundwater flow calculations indicate the average linear horizontal velocity of flow in the organic deposits is approximately 120 ft/year. Since Ley Creek is within 350 feet of the landfill, groundwater flowing beneath the landfill should reach Ley Creek within 3 years.

The organic deposits are separated from a deeper permeable sand and gravel deposit by 12 to 54 feet of silt and clay. Water level measurements in the deep piezometers installed to monitor groundwater movement in the sand and gravel layer show a significant seasonal variation in the direction of groundwater flow in this deposit. The horizontal direction of groundwater flow reverses from eastward in the summer to westward in the winter. Vertical gradients between the sand and gravel aquifer and organic deposits also reverse from upward in the summer to downward in the winter when the potentiometric surface in the sand and gravel aquifer declines 15 to 20 feet. The sand and gravel layer is an artesian aquifer, confined by the silt and clay deposits which separate it from the overlying organic deposits.

Any leachate produced by the landfill should flow horizontally through the organic deposits toward Ley Creek. The silt and clay deposit underlying the peat will restrict vertical migration of leachate due to its lower hydraulic conductivity. Moreover, vertical gradients between the underlying sand and gravel aquifer and organic deposits are upward during much of the year (April-early December) forming an additional restriction to downward migration of leachate. Thus, the effect of the landfill on water quality should be restricted to groundwater in the organic deposits.

Wells W-6A, W-8A, W-1 and W-3 are downgradient monitoring points in the organic deposits. However, a new upgradient well in the organic deposits is needed to evaluate the difference between background water quality in the organic deposits and water quality in the organic deposits downgradient of the landfill. Well W-4A is not an adequate background monitoring well because it is not always upgradient of the landfill and was installed through fill which contained foundry waste. A new upgradient monitoring well should be placed further from the landfill and in an area where there is no foundry waste.

An additional downgradient monitoring well should also be placed in the sand and gravel deposit to monitor water quality in this unit during summer flow conditions when the direction of flow is eastward. Well W-4B is the only downgradient monitoring well during summer flow conditions when the direction of flow in the sand and gravel unit is eastward. When the direction of flow is westward (winter flow conditions) wells W-7, W-6B and W-5 all provide downgradient monitoring points. Due to the reversal in flow direction it is difficult to locate an upgradient monitoring well in the sand and gravel deposit. Well W-8B is in the best location for providing background water quality in the sand and gravel aquifer because it is cross gradient to the direction of flow under both winter and summer flow conditions and is at the edge of the landfill.

Respectfully submitted,

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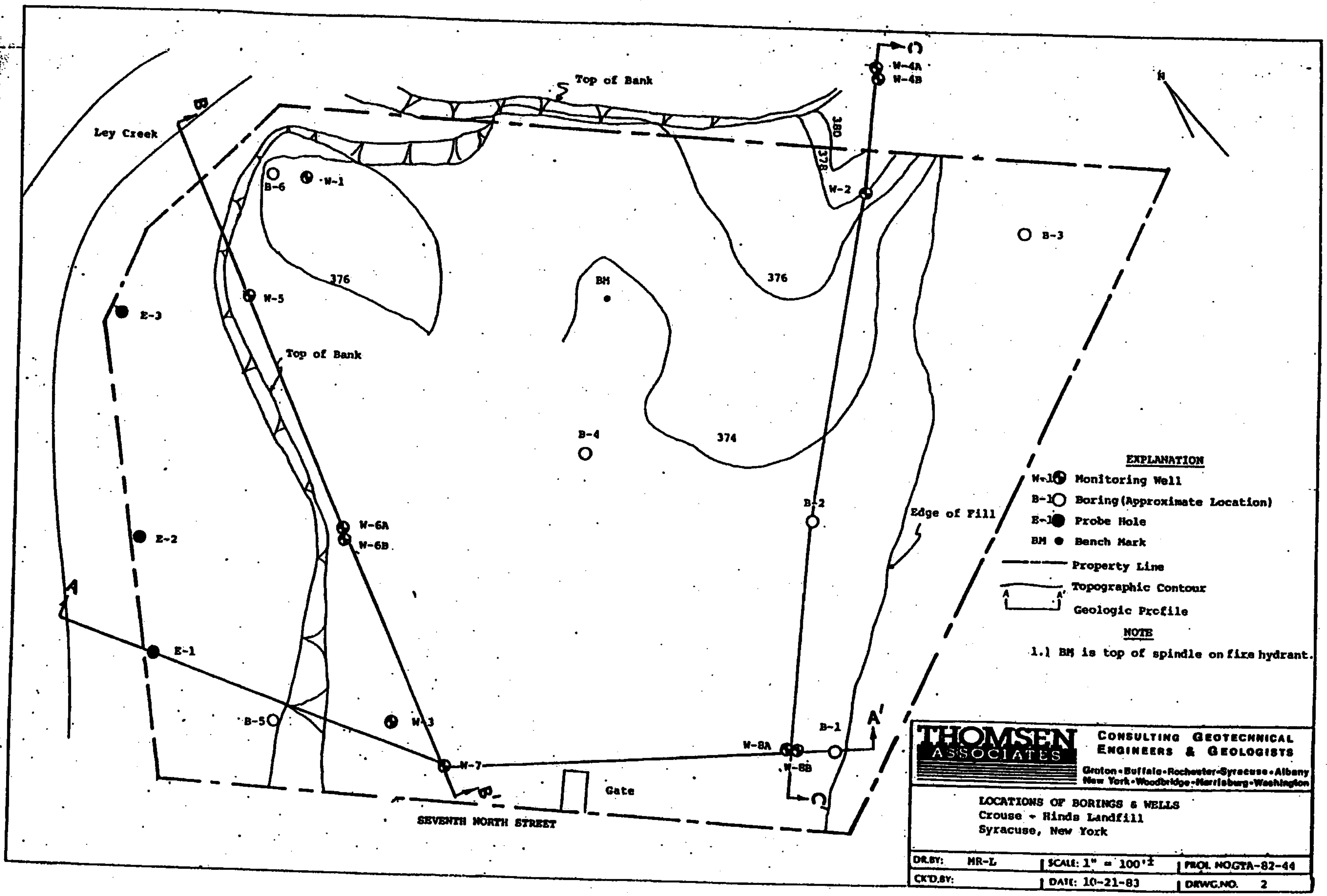

Top of Bank
Ley Creek
B
W-4A
W-4B
C
N
380
378
W-1
B-6
W-2
B-3
376
376
BM
W-5
E-3
Top of Bank
B-4
374
EXPLANATION
W-1 Monitoring Well
B-1 Boring (Approximate Location)
E-1 Probe Hole
BM Bench Mark
Property Line
Topographic Contour
Geologic Profile
NOTE
1.) BM is top of spindle on fire hydrant.
B-2
Edge of Fill
W-6A
W-6B
E-2
A
E-1
B-5
W-3
W-7
B'
Gate
SEVENTH NORTH STREET
W-8A
W-8B
B-1
A'
C'
THOMSEN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS
Groton • Buffalo • Rochester • Syracuse • Albany
New York • Woodbridge • Harrisburg • Washington
LOCATIONS OF BORINGS & WELLS
Crouse - Hinds Landfill
Syracuse, New York
DR.BY: MR-L
SCALE: 1" = 100'±
PROJ. NO. GTA-82-44
CK'D.BY:
DATE: 10-21-83
DRWG.NO. 2